ITI CEC Workshop

Aug 31, 2011

Henry ML Wong,
Sr. Power Technologist
Henry.L.Wong@intel.com, 408-765-5047

Computers and Servers

- Personal computers, servers and ICT equipment are continuously becoming more efficient
- Data centers and IT infrastructure are already aggressively driving energy efficiency
- ICT equipment/technology enables energy efficiency in other industries

Energy Efficient IT and the Economy

Traditional Banking

Automation Documented

Online Banking

- "For every extra kwhr that has been demanded by the ICT[1], the US economy increased its overall energy savings by a factor of 10." - American Council for an Energy Efficient Economy (ACEEE)[2], 2/08
- Key to energy efficiency: higher productivity not just lower energy consumption

Historic Economic Energy Efficiency 10:1
Challenge: Continued Economic Energy Efficiency

[1] ICT : Information and Communication Technology
[2] Information and Communication Technologies: The Power of Productivity, J. Laitner and K. Erhardt-Martinez, Feb.2008, ACEEE Report #E081

Information Technology Industry Council
Leading Policy for the Innovation Economy

Global Technology Growth

1 Billion
New Connected Users by 2015

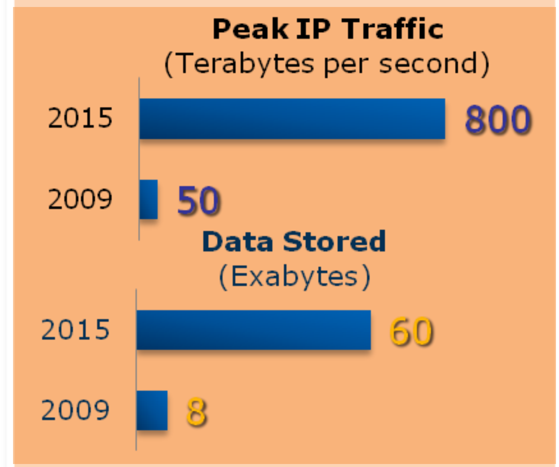
More Users

+10 Billion
Connected Devices

More Computing Devices

800 TBytes
IP Traffic

60 EBytes
Data Stored



More Data

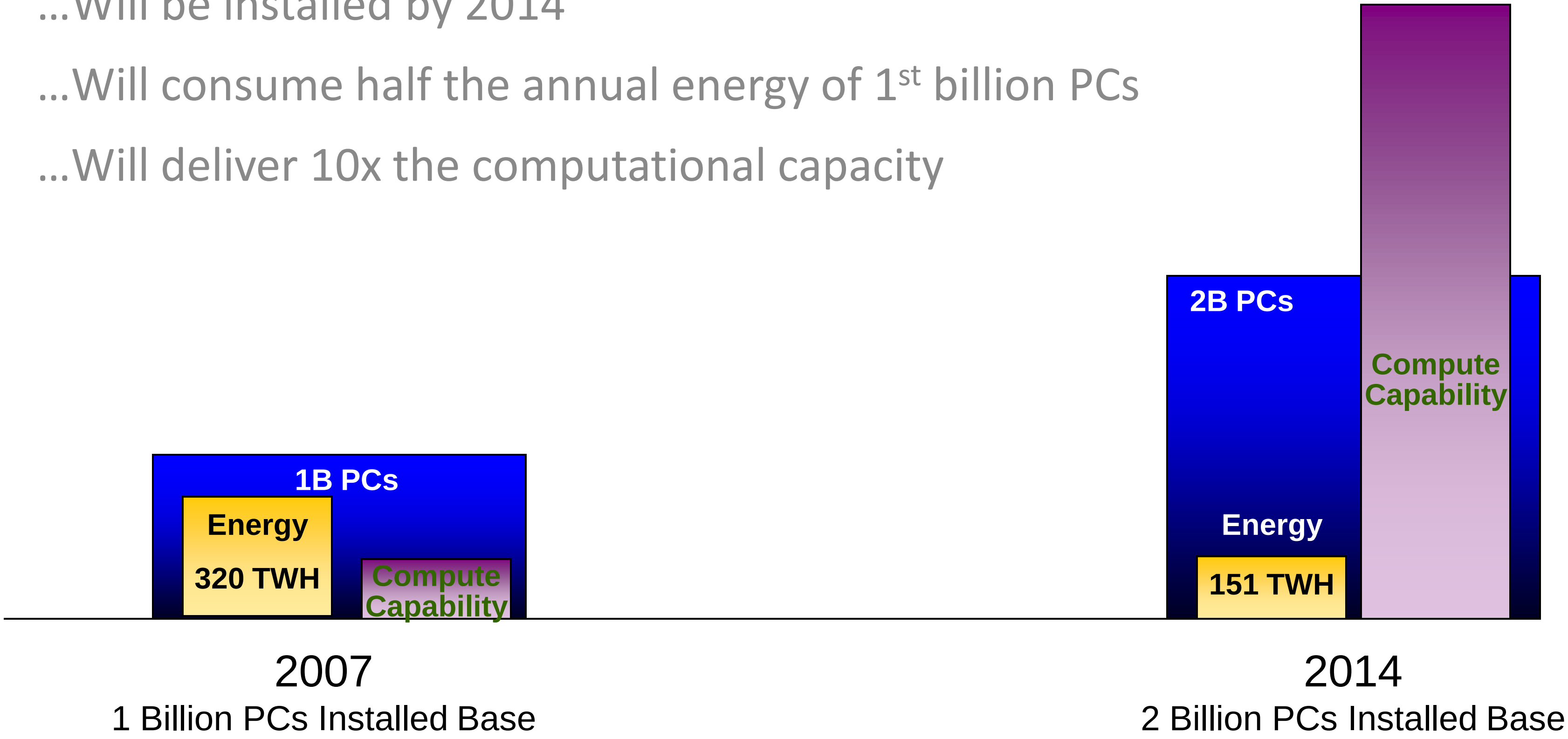
Compared to the first Billion PCs installed…

2 Billion PCs…

…Will be installed by 2014

…Will consume half the annual energy of 1st billion PCs

…Will deliver 10x the computational capacity



Computers and Servers

Voluntary programs and market demand are already driving computers and servers to aggressively approach energy efficiency. ICT is continuously increasing productivity to support economic growth and IT demand.

Energy Efficiency in Computers

- Increased Power Management Reduces Energy Consumption
- Configuration flexibility drives efficiency innovations in subsystems
- Power conversion and delivery efficiency

Efficiency in Personal Computers

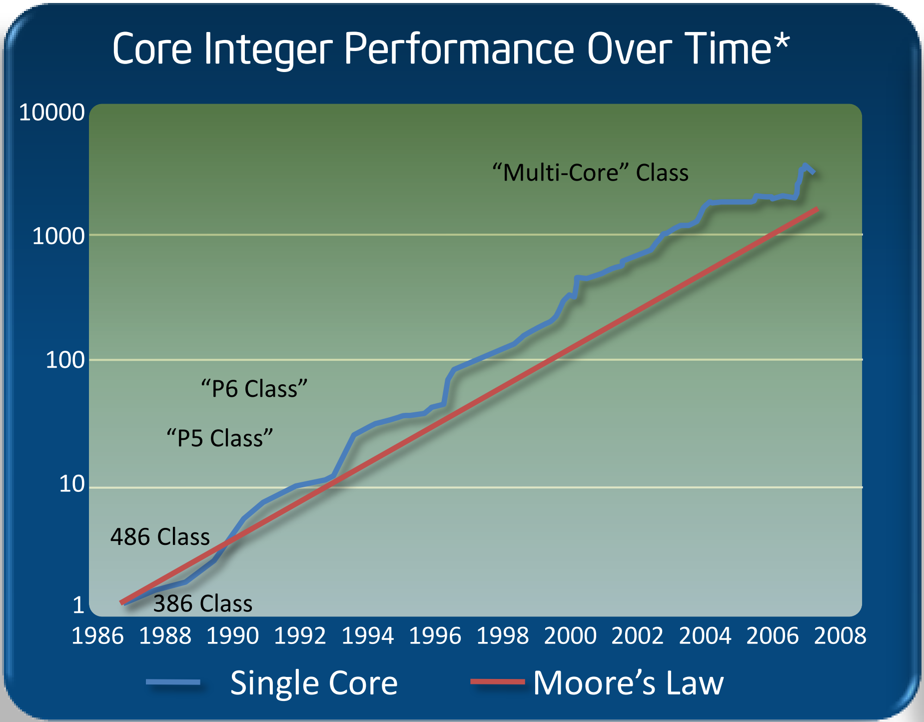
- Mobility drives PC energy reduction
- Increase battery life
- Platform focused on Race to Halt- get it done and go to sleep
- Identification and reduction in annoyance modes
- Multi-function: communication, creation, entertainment, daily tasks, retail

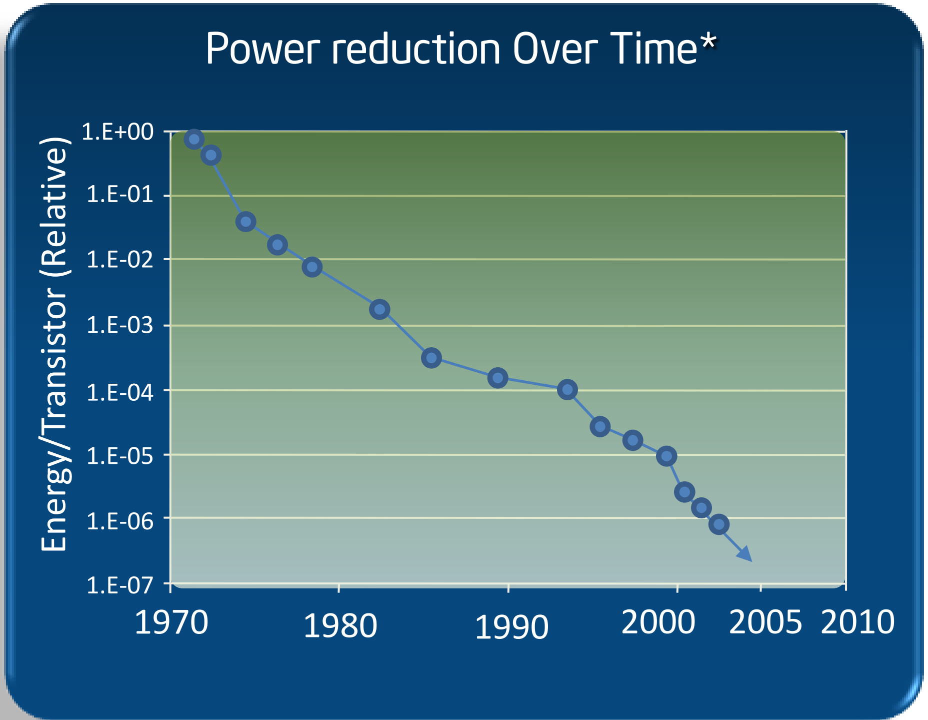
Efficiency in Servers and Data Centers

- Maximizing productivity within an energy envelope
- Consolidation
- Virtualization
- Varied data center configurations to address a variety of industries, applications, reliability, and security levels
- Rack and data center level energy efficiency to address cooling and power delivery
- Best practices: The Green Grid, Data Center Efficiency Practitioner, Data Center Code of Conduct, Energy Star for Servers, Energy Star for Data Centers, …

6

Moore's Law drives Energy Savings at the silicon



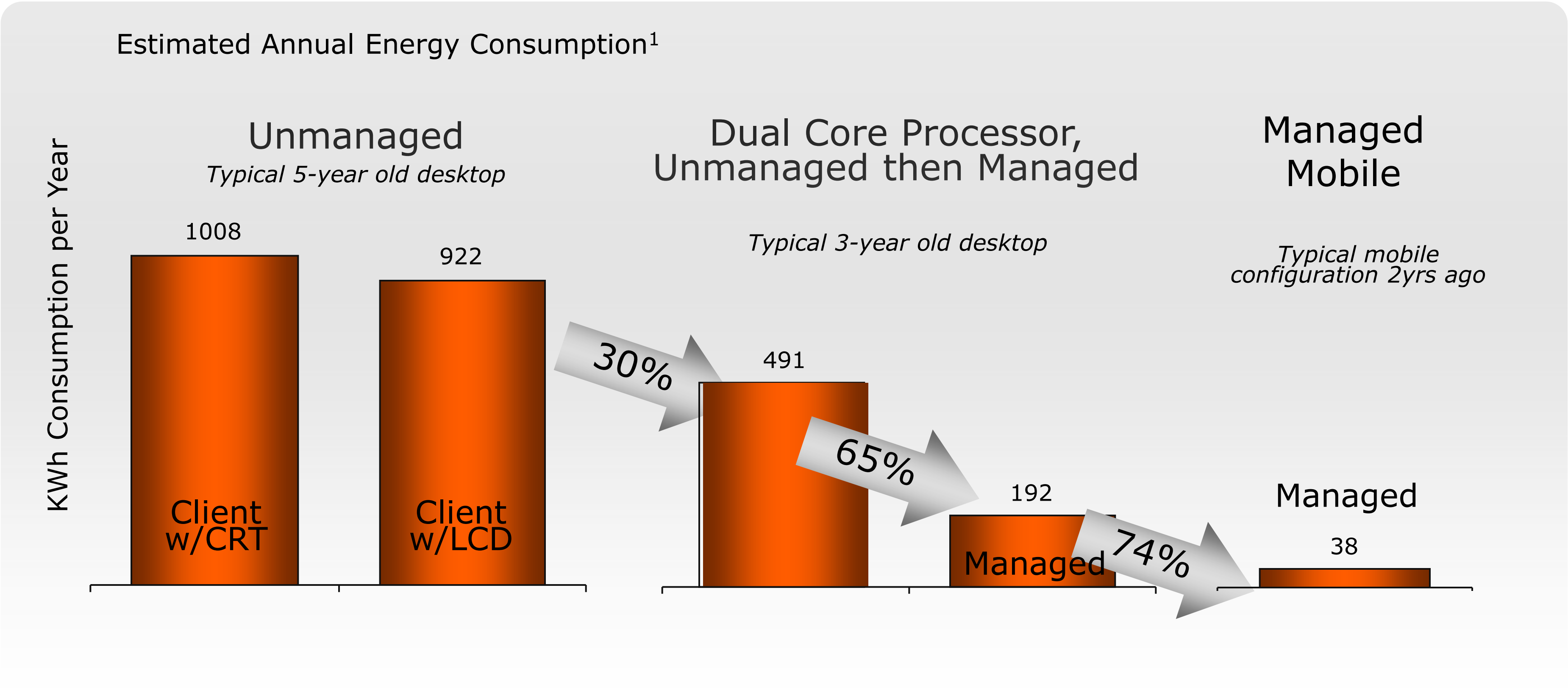


~ 1 Million Factor Reduction In Energy/Transistor Over 30+ Years Delivering
Great Performance Within Power Envelope
Compute Energy Efficiency ➔ Positive Impact On Environment

Additional Reference: http://doi.ieeecomputersociety.org/10.1109/MAHC.2010.28>

Source: Intel Corporate Technology Group

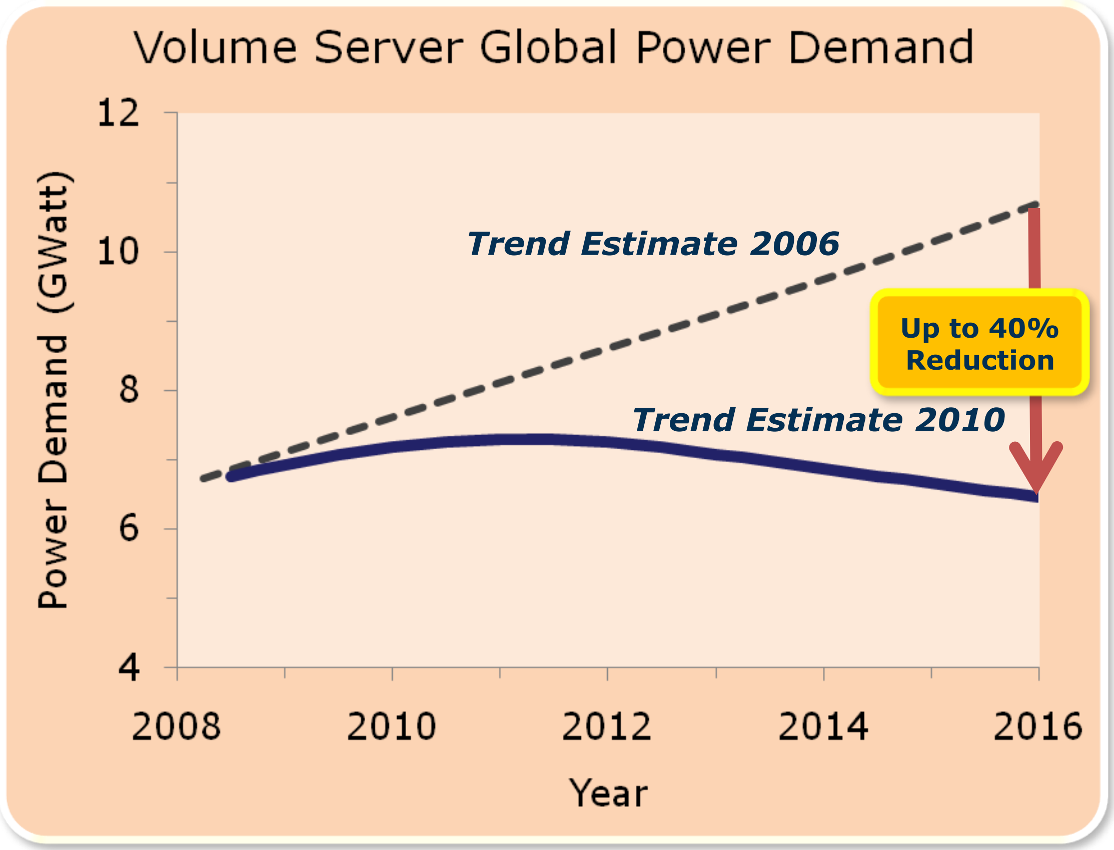
Refresh, Power Management, & Form Factor Drives significant power savings



Adopt Power Management. Refresh IT.

Estimated Annual Energy Consumption[1] based on typical energy consumption (TEC) Energy Star for Computers v5 calculations in a corporate enterprise workload. Other markets and usage assumptions will vary.

Server Efficiency Focus: Productivity Gains, Fixed Energy Budget



Assumes Four Year Server Refresh Cycle.

By 2016…

- Number of Servers to Increase by 1.5X
- Compute Capacity to Grow 9X
- Total Server Energy Consumption to **Stay Constant**

Server Improvements Driving Data Center Energy Efficiency

SERVER ENERGY EFFICIENCY
Server Refresh: Example 2006->2010

Information Technology Industry Council
Leading Policy for the Innovation Economy

2006

5 racks Dual Core Servers

2010

Efficiency Refresh 5:1

1 rack of Quad Core based servers

85% Annual Energy Cost Reduction

Performance Refresh 1:1

5 racks of Quad Core based servers

Up to 5x Users Supported

10% Annual Energy Costs Estimated Reduction

Source: Intel measurements as of Feb 2010. Performance comparison using server side java bops (business operations per second). Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance. For detailed calculations, configurations and assumptions refer to the legal information slide in backup.

Unintended Consequences of Regulations

Computers

- Reduces consumer choice
- Stalls personal productivity
- Increased annoyance modes
- Reduces mobility
- Stalls innovation and new technologies

Servers:

- Drives reverse consolidation and increase data center footprint
- Reduces reliability and availability
- Reduces efficiency of supported industries

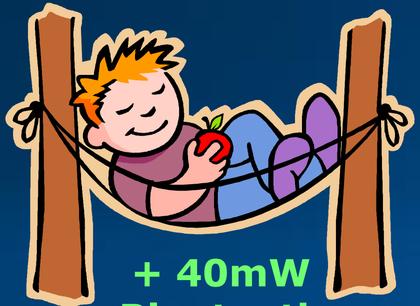
11

Analogy: Idle Devices & Crying Babies

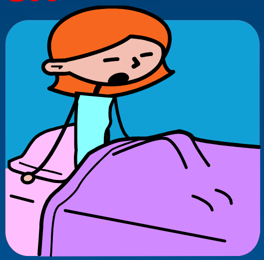
- Idle devices should excel at ***"Doing Nothing"***
- Crying Babies
  - Babies are small, don't consume much energy
  - Baby sleeps at night everyone sleeps
  - A crying baby prevents everyone from resting

+ 590mW GMCH

+ 6050mW CPU

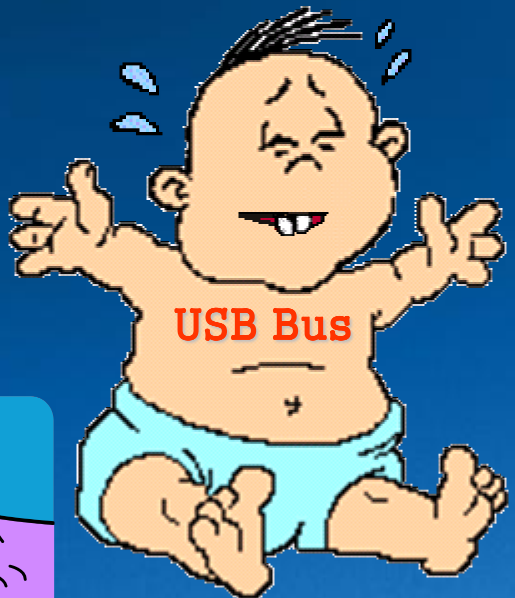


+ 40mW Bluetooth



+ 170mW Memory

+ 60mW Clock Chip



+ 0mW EHCI

+ 310mW EHCI

"USB2 Crying" increases idle platform power by 7W!

Need to focus on the platform (household), not just the feature (baby)!

**** Any similarities to real or imagined technologies is purely coincidental**

Which is more efficient? (4 Socket Comparison)

Individual Server A	
Max Power	663 W
Idle Power	336 W
Capacity	334.3 Kbops/system

Individual Server B	
Max Power	715 W
Idle Power	358 W
Capacity	411.7 Kbops/system

To meet IT Requirement of 5.0 Mbops

Rack A		Rack B	
Capacity	5.02 Mbops	Capacity	5.35 Mbops
Systems	15	Systems	13
Total Idle	5.04 kW	Total Idle	4.65kW

Choosing Server B is MORE Efficient
Saves 4.54 MWhrs to 3.73 MWhrs per yr.**

Performance is Key to Server Energy Efficiency

Best Known Methods/Practices

- The Green Grid
- Save Energy Now
- Climate Savers Computing Initiative
- Silicon Valley Leadership Group
- Data Center Dynamics
- Critical Facilities Roundtable
- ASHRAE
- SPEC
- ENERGY STAR

* Logo's are the property of individual owners.

14

Conclusions/Recommendations

- Computers and Servers are continuously driving energy efficiency in its own footprint and in other industries, while increasing productivity to keep up with computing demands
- Energy efficiency approach on client computers is very different to that of servers and enterprise equipment. No single configuration or workload can represent the usage model of computers across the various categories.
- Voluntary measures provide incentives for a narrow scope of product to accelerate efficiency across the various markets, applications, configurations and ICT demands in client and enterprise computing equipment.
- Usage behavior is the predominant driver for energy use. Consumer training, refresh and best practices are the most effective means for continued energy efficiency. Product regulations stalls energy efficiency innovation and adoption.
- Recommend comprehensive market assessment with only verifiable data (reviewed by industry experts) be used as a basis for developing regulations. Such a market study and industry expert review is necessary to ensure that energy efficiency regulations being proposed, are appropriate and do not inadvertently impact customer requirements.

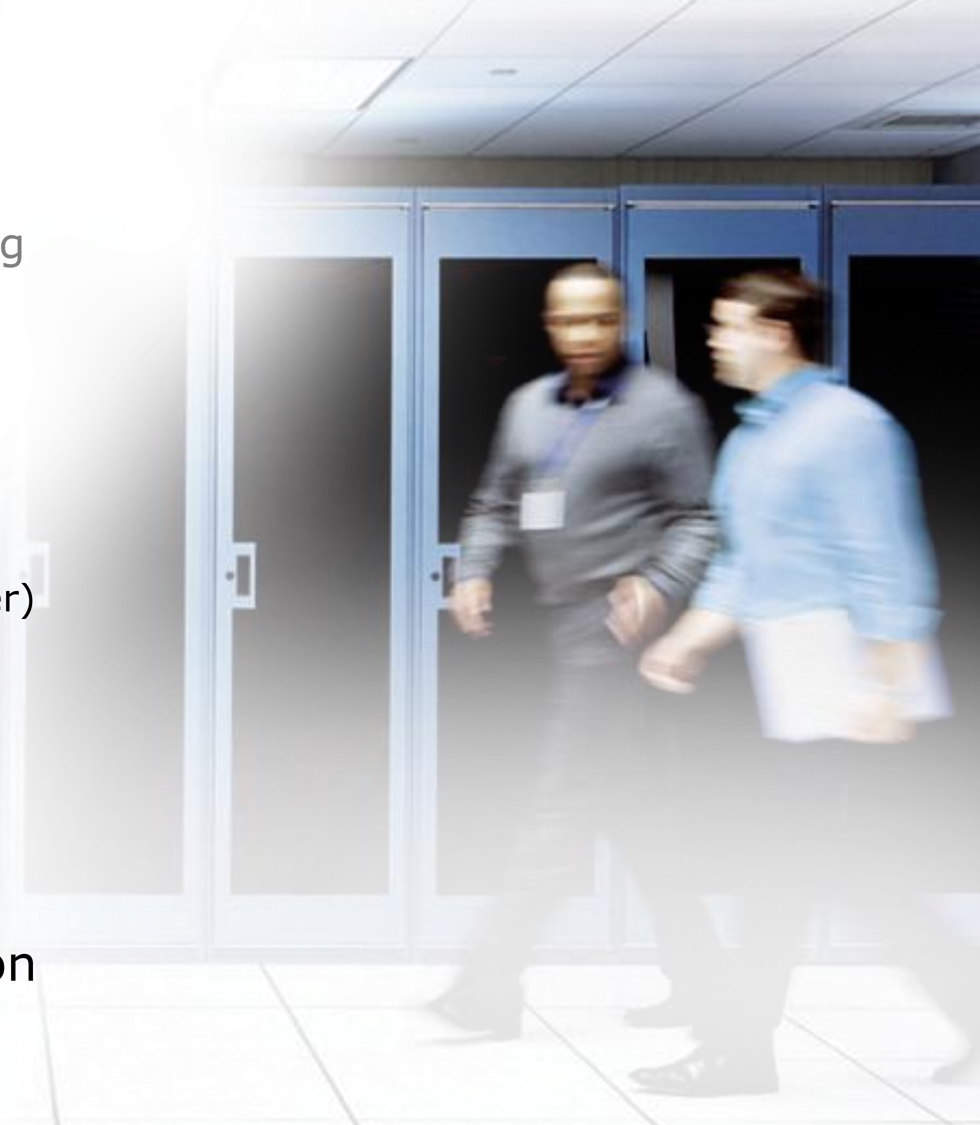
15

Backup

the green grid

Global consortium dedicated to advancing energy efficiency in data centers and business computing ecosystems

- Defining energy efficiency metrics and assessment tools
  - PUE and DCiE
    (Ratio of IT Power to Data Center Power)
  - Performance-based IT workload metric in development
- Promoting use of standards and Data Center best practices
- Driving Data Center instrumentation standardization



climate savers
smart computing

- Increase computing energy efficiency
- Increase use of power management

Energy Efficiency Impact of Optimizing Idle Power

	Idle power regulations				Enterprise Energy Efficiency			
Server Characteristics	**1P**	**2P**	**4P w/16GB**	**4P w 128GB**	**1S**	**2Socket**	**4Socket; 8 DIMM**	**4Socket; 16 DIMM**
IDLE Power	60W	150W	270W	460W	Varies (60-150W)	Varies (135-400W)	Varies (250-700W)	Varies (400-900W)
Efficiency Rate	n/a	n/a	n/a	n/a	SpecPower	SpecPower	TPC/W; Linpack_Ops/W	TPC/W; Linpack_Ops/W
Peak Compute	n/a	n/a	n/a	n/a	SpecCPU-rate> xx	Linpack> yy SpecCPUrate>	TPC> xxx Linpack > yyy	TPC> xxx Linpack > yyy
Dynamic Load Balancing	n/a	n/a	n/a	n/a	xxW/20% (system)	yyW/10% (system)	VMM migration yyyW/10%load (racks; datacenter)	VMM migration yyyW/10%load (racks; datacenter)

Selection Results		
	Lowest performance processor	**Highest Performance Processor configuration**
	Smallest and slowest amount of memory	**Large resident, coherent, fast memory config**
	Fewest features possible	**Integrated power management**
	Reports data. Controls too slow to adjust.	**Dynamic automated load & resource balancing**
	Optimizing for low Idle results in: Low Capable system; Stalls energy efficiency (rate); Slows virtualization (smaller capacity) ; Slows down consolidation (small capacity)	

Optimizing for Low_Idle_Power does *not* result in improving Energy_Efficiency in the datacenter

Servers

Industry programs and narrowly scoped voluntary measures are already driving energy efficiency

Hardware improvements:

- Improved power supply efficiency
- Virtualization Capability: 1 server can do the work of 3 to 12 or more servers
- Power Management functions reduce power use by 30 to 60% when no workload is present
- Increased workload delivery for unit of power consumed in combination with greater server utilization (Virtualization)

Data Center Improvements supported by HW capabilities:

- The Green Grid (TGG)- best practices. PUE, Economizers, Power Delivery, Power Management
- Data Center Code of Conduct
- Save Energy Now- Data Center Efficiency Practitioner
- Energy Star for Servers- reuse techniques into other ICT categories

20